One Engineer's Opinion

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Q. *Section 1.13 of the Commentary to the AISC Specification suggests that the depth of beams and girders "subject to shock and vibration" should be limited to $F_y/650{,}000$ times the span. What criteria should be used to anticipate a vibration condition? Are vibration conditions apt to be encountered in typical offices, residential buildings, stores, etc. which do not involve manufacturing operations?*

A. Unsatisfactory vibration characteristics in steel framed buildings are the exception rather than the rule; therefore, it would be unreasonable to penalize all structures by arbitrarily limiting the span-depth ratios for beams to such a conservative degree as to guarantee that objectionable vibrations would be avoided in all situations. For this reason, the arbitrary span-depth limitations which formerly governed deflections and stiffness in earlier versions of the AISC Specifications were removed from the body of the Specification and placed in the Commentary as cautionary guides.

Vibrations which are due to rotating machinery, such as air-conditioning and ventilating fans, can most readily and economically be eliminated by isolating the source of the vibrations on vibration dampener foundations, rather than by designing floor members with more depth than required for normal stress and live load deflection requirements.

However, it is not necessary to have rotating machinery or vehicular traffic to produce vibrations. The footfalls of normal pedestrian traffic in lightly loaded, lightly constructed buildings which have a bare minimum number of interior partitions and relatively long spans may produce objectionable vibrations even though the structure is completely satisfactory from the standpoint of stress and deflection.

In the large majority of buildings, the natural damping provided by partitions, suspended ceilings, built-in furniture and other equipment is adequate to cause a rapid decay in transient vibrations, and results in satisfactory vibration characteristics. In buildings containing a reasonable distribution of partitions, equal to a typical plastered partition, the damping provided will probably be adequate and beams which are satisfactory from the standpoint of unit stress and live load deflection will provide a floor not subject to objectionable vibration. However, in buildings having wide open areas, such as churches, stores and theaters, vibration may be a problem.

It would be prudent, therefore, in buildings with large open areas and long spans of light construction, to limit the beam depth-span ratios to $\frac{1}{20}$. The minor deflection (vibration) caused by the footfall of normal pedestrian traffic is resisted by the composite action between slab and beam, whether shear connectors are used or not. Since the recommended ratio is based solely upon past experience, most of which has dealt with constructions where shear connectors were not used, it would seem unwise to liberalize it by substituting the composite beam depth for the bare beam depth when shear connectors are used.

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